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Cancer Rates in a Community Exposed to Low Levels of Creosote Components in Municipal Water

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IN NOVEMBER, 1978, the Minnesota Department of Health detected minute (nanogram per liter) quantities of various polynuclear aromatic hydrocarbons (PAH), including pyrene, fluoranthene, anthracene, and naphthacene, in several municipal and industrial wells in the city of St. Louis Park, a suburb of Minneapolis¹. Although there are no official U.S. standards for PAH in water supplies, four municipal wells were closed immediately because the amounts exceeded the World Health Organization's recommendation for safe levels in drinking water². PAH compounds were not detected in the remaining ten municipal wells.

The PAH compounds apparently originated from the site of a plant which distilled coal-tar products and treated wood with creosote from 1917 to 1972. During this time, wastes from the plant's operations were deposited on the surface of the site, allowing contamination of the groundwater reservoirs below.

It is not known how long PAH compounds have been in the St. Louis Park water supply, since techniques for their detection in water have only been available in the past few years³. A well drilled in 1932, however, was shut down within a few months due to a creosote-like odor and taste of the water, and it is possible that PAH compounds have been in the municipal water for many years or decades in low concentrations.

The occurrence of PAH in the environment is of concern because of their demonstrated carcinogenicity for animals and/or mutagenicity for bacteria.⁴⁻⁹ There appear to be no epidemiologic studies of human populations exposed to low levels of PAH in water supplies, although the association of occupational skin cancer with creosote and coal-tar compounds has long been known^{10,13}.

The Minneapolis-St. Paul area, including St. Louis

Park, was part of the Third National Cancer Survey¹⁴ conducted for the three years, 1969 to 1971. All hospital records in the five county Twin Cities area were searched for cancer diagnoses, and abstracts of cancer records were coded on computer tape. Because of the availability of these records on tape, albeit for a limited three year period of time, it was decided to compare cancer incidence rates in St. Louis Park with those in the nearby municipalities of Edina and Richfield and in the entire Minneapolis-St. Paul Standard Metropolitan Statistical Area (SMSA).

Methods

Incidence rates for 45 types or sites of cancer were calculated for St. Louis Park, Edina, Richfield, and the Minneapolis-St. Paul SMSA using data from the Third National Cancer Survey for the three years, 1969-1971. Richfield was selected because it was a SMSA suburb similar to St. Louis Park in social and economic characteristics such as median school years completed, percent high school graduates, occupation and median and mean family income. Edina was selected because the creosote contamination was believed, at that time, to be moving toward Edina. The entire SMSA was used as the major comparison area. Incidence rates were age-adjusted to the SMSA populations of white males and white females respectively. Calculations were done of average annual age- and sex-specific cancer incidence rates, age-adjusted incidence rates, standard incidence ratios (SIR), Mantel-Haenszel overall summary Chi-squares^{15,16} and Z statistics. The latter two statistics are used to assess the significance of the difference between two rates after adjusting for age. Population denominator data were taken from the 1970 U.S. Census¹⁷.

Results

For males, no cancer rates in St. Louis Park were statistically significantly different from those in the three comparison areas. Among females, age-adjusted rates for all cancer sites combined, for breast cancer, and for cancers of the gastrointestinal tract were higher

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in St. Louis Park than in Edina, Richfield, and the SMSA. The excess in gastrointestinal cancer rates for females was only slightly significant ($P < .05$) but all cancer sites combined and breast cancer had differences with a high degree of statistical significance ($P < .0005$). Further details of the significant comparisons are given in the Table.

Discussion

In the absence of epidemiologic literature on ingested exposure to PAH, it is of interest to note that rats fed one PAH compound — 3-methylcholanthrene — develop mammary carcinoma in high frequency and these tumors occur almost exclusively in females.¹⁸⁻²⁰ Other PAH compounds produce a variety of tumors in animals⁴.

Breast cancer rates vary considerably with geographic location and with characteristics of the population^{21,24}. In the Third National Cancer Survey¹⁴, for example, the rates varied from 59 to 83 per 100,000 white females per year in the nine different study areas. In a recent review of the epidemiology of human breast cancer, Kelsey has summarized the influence of major factors known to influence breast cancer rates, expressing the results as relative risks (RR) — the ratio of case rates in a population with the factor to the rate in those without the factor²⁴. These include: (1) First degree relative with breast cancer (RR of 2-4); (2) Absence of or late age at first full-term pregnancy (RR of 2-4); (3) History of fibrocystic disease of the breast (RR of 2-4); (4) Exposure to high levels of radiation to the chest (RR of 2-4); (5) Upper socio-economic class (RR of 2-4); (6) Obesity (RR of 2-4); and (7) Early age at menarche and late age at

menopause (RR of 1.1-1.9). Rates given in the literature for Jewish populations are contradictory, varying from less than to higher than those for non-Jewish whites^{25,27}. The contribution of these factors to the difference in breast cancer rates between St. Louis Park and the comparison areas cannot be evaluated without further information about the individual cases. Because of the sizable population with Jewish ancestry, estimated to be 20% in 1971²⁸, the influence of this factor is of particular interest, but would not explain the 1.5 fold difference in rates even if 20% of the St. Louis Park breast cancer cases were Jewish and a two-fold relative risk existed.

The lack of elevation in the rates for the great majority of cancer types is reassuring, but factors responsible for the elevation in breast cancer rates in St. Louis Park need to be investigated. Further interpretation must await interviews of the 95 cases of breast cancer or their families and an appropriate control group. The results of such a detailed case-control study, now in the planning phases, may explain the elevated breast cancer rates in St. Louis Park on the basis of the frequencies of known risk factors. If this is not the case, further studies to explore a possible relationship with the water supply must be considered.

At the present time, the elevated incidence of breast cancer cannot be attributed to the water contamination, although the limited information available does not rule out such an association. It should be noted that the wells found to be contaminated have been closed, presumably reducing any hazard which may have been present.

TABLE
Cancer Incidence Rates for Total Cancers and Breast Cancer
St. Louis Park and
Three Comparison Populations
White Females Only, 1969 to 1971

	Breast Cancer		All Cancers	
	Population	Total Cases 1969-1971	Average Annual Age-Adjusted Rate* per 100,000 pop.	Total Cases
St. Louis Park	25,424	95	113	301
Edina	22,492	65	82	175
Richfield	24,247	41	58	145
MSP SMSA	914,218	2130	78	7726

*Rates per 100,000 white females, adjusted to the MSP SMSA population of white females, 1970.

Mantel-Haenszel Summary Chi-Square Values and P-Values

Comparison	CHI-SQUARE		P-VALUE	
	Breast Cancer	All Cancers Females	Breast Cancer	All Cancers Females
St. Louis Park vs Edina	3.38	19.90	.05 < p < .1	< .0005
St. Louis Park vs Richfield	10.85	21.18	.001	< .0005
St. Louis Park vs SMSA	13.84	24.31	< .0005	< .0005

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Cover Photograph "Winter's North Shore"

Dr. Earl C. Henrikson takes an annual trip to the North Shore with the Minneapolis Chapter of the Audubon Society. The members of the Society check the winter birds as well as the boundaries of the lake shore, trails, and streams. It was during one of these trips that the cover photograph was taken.

Dr. Henrikson is a Minneapolis surgeon and has been a yearly contributor to the covers of MINNESOTA MEDICINE. His cover "Waiting for Breakfast" (November, 1978 issue of MINNESOTA MEDICINE) won the Outstanding Cover Award.